Cirsium ochrocentrum subsp. *martinii* (Asteraceae), a New Subspecies of the Santa Fe Thistle from the Gila River Region of Arizona and New Mexico

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Abstract. A morphological study of *Cirsium ochrocentrum* supports separation of the phenotype with red corollas of the upper Gila River drainage from typical materials with purple or white corollas from surrounding regions. This taxon shows intergradation and overlap of character distributions with typical populations and is recognized as a subspecies. *Cirsium ochrocentrum* subsp. *martinii* differs from the typical variety by its red corolla color, short style tips and spines, and generally shorter decurrence.

The American thistle genus *Cirsium*, with over 140 species (Ownbey et al., 1975), is an important part of the North American flora. Although American thistles have been falsely maligned as aggressive weeds because of their Eurasian congeners (Lamp & McCarty, 1981), western thistles provide a vital, and sometimes obligate, food source for many animal species including goldfinches, hummingbirds, and crescent butterflies (Martin et al., 1951; Tilden & Smith, 1986). Despite the ecological importance of these plants, taxonomists have largely neglected thistles. Current thistle taxonomy has both a confusing number of synonyms and a multitude of undescribed phenotypes that merit taxonomic recognition. In this report, I describe one such unrecognized group.

Ownbey and Hsi (1963) suggested that the red-corolla phenotype of the Santa Fe Thistle, *Cirsium ochrocentrum*, might warrant recognition at the subspecies or species level. Hsi (1960) proposed a new taxon based on materials from Arizona with red corollas but did not validate the name with a published description. Barlow (1992) studied variation within the *C. ochrocentrum* group and showed that the red-flowered phenotype, which is found in the Gila River drainage of southeastern Arizona and southwestern New Mexico, was separable from the normally purple-flowered populations of the Rio Grande, Great Plains, Trans-Pecos, and Colorado Plateau. A summary of that analysis and the resulting description is presented here.

Methods and Materials

Twelve morphological characters were measured on field-collected specimens from 56 populations (Fig. 1). Voucher specimens are deposited at UNM. The morphological characters used in this analysis were terminal leaf spine length, decurrence length, leaf length, corolla tube length, corolla throat length, corolla lobe length, style tip length, anther appendage tip length, anther appendage body length, pappus length, phyllary length, and phyllary spine length. Each population was represented by 1 to 18 specimens, and each floral character was represented by the average of 10 measurements per plant. This data set and the characters are fully described in Barlow (1992).

A canonical discriminant analysis (CDA), using population averages, was used to graphically portray the distinctiveness of the red-corolla populations of the Gila River drainage from the typical Rio Grande valley purple-corolla populations. A third group, consisting of specimens from geographically intermediate populations with intermediate colors, was included to both verify their intermediacy in other character states and to offset the polarization of a CDA with only two taxa. Individuals were assigned to one of these three groups for this analysis. Discriminant analysis gives a linear combination of characters that best describes the classification. Ninety-five percent probability ellipses for the variance of each population were calculated. In a second analysis, 65 purple-corolla specimens from the upper Rio Grande Valley near the type locality of the typical subspecies were compared with 49 red-flowered specimens from Catron County, New Mexico, in a Kruskal-Wallis non-parametric comparison of the means. Statistical analysis was performed with NPAR1WAY, CANDISC, and IML procedures of the Statistical Analysis System (SAS Institute, 1989). Two hundred twelve herbarium specimens of *Cirsium ochrocentrum* were examined.

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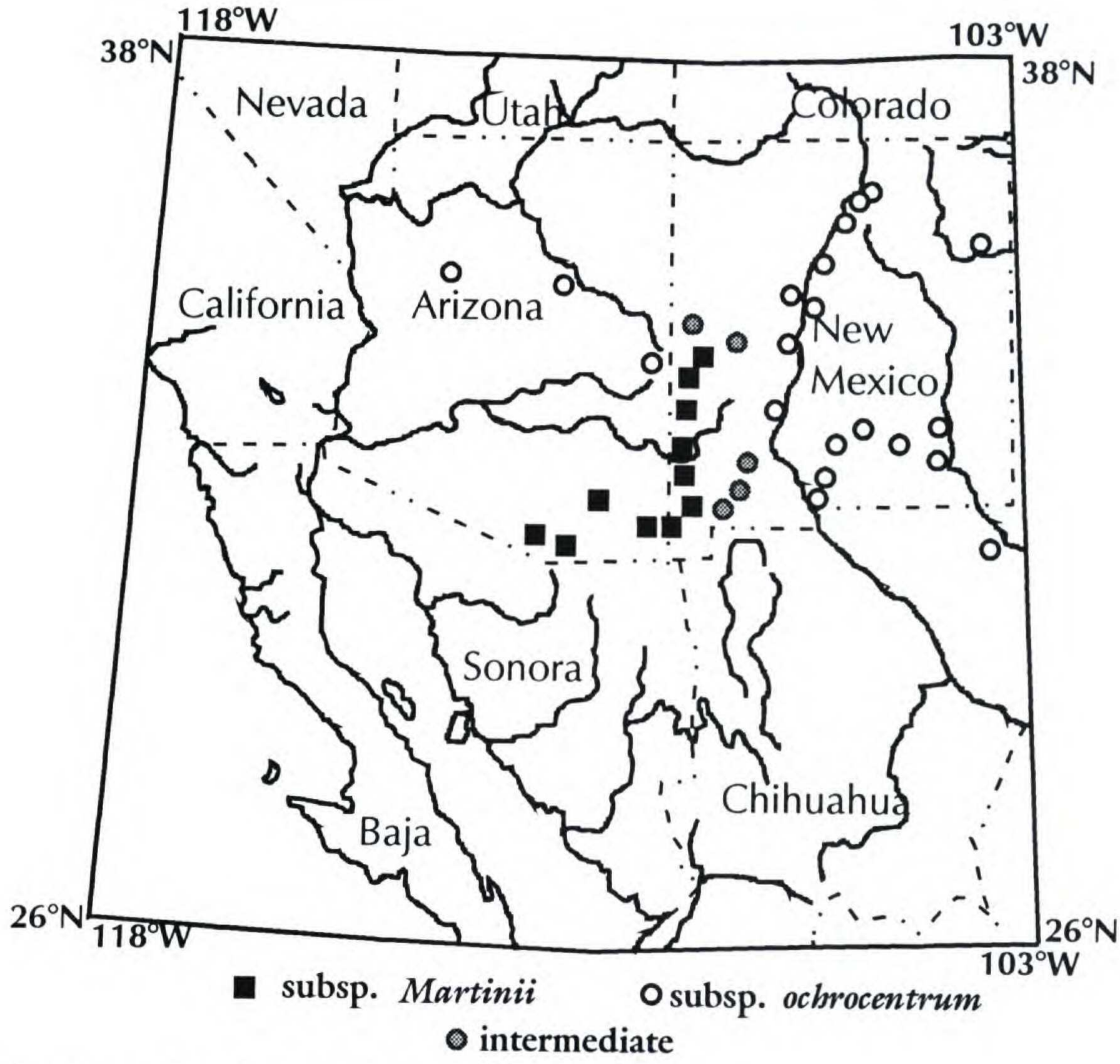

Figure 1. Distribution of populations under study.

Results

The CDA procedure separated the red (Gila) and purple (Rio Grande) phenotypes except for a small intersection (Fig. 2). These two color phenotypes separated along the first canonical axis, with the geographical intermediates placed near their intersection. The canonical correlations of the first axis are highly significant at $P < 0.0001$, while those of the second axis are not significant (Table 1).

The first canonical axis explains 92.7% of the total variance between phenotypes. This axis contains a linear combination of all quantitative characters with length of both anther appendage variables, phyllary spine length, and style tip length being the most prominent factors (Table 2). The Kruskal-Wallis comparison of means for the Gila and Rio Grande phenotypes results in significant differences in 10 characters although there is extensive overlap in the distribution of characters (Table 3). Pappus length and phyllary length are not significantly different between these phenotypes.

Discussion

These analyses support the recognition of *Cirsium ochrocentrum* subsp. *martinii* by showing that using quantitative morphological characters alone, the two taxa can be separated with very little overlap when geographically intermediate populations are excluded. The small degree of overlap between the taxa, despite the power of CDA to divide groups, indicates that they are not divided by any discontinuous character distributions, as evidenced in Table 3. Although these taxa have different corolla colors and morphological features, they apparently intergrade in the intermediate populations along the narrow zone of contact between their geographical ranges. Some authors might rank these two taxa as separate species; however, a conservative approach, ranking them as subspecies, better reflects the close relationship and high degree of morphological similarity, relative to more differentiated congeners. The subspecific rank denotes morphologically distinguishable, geographically separate groups within species (Davis, 1978).

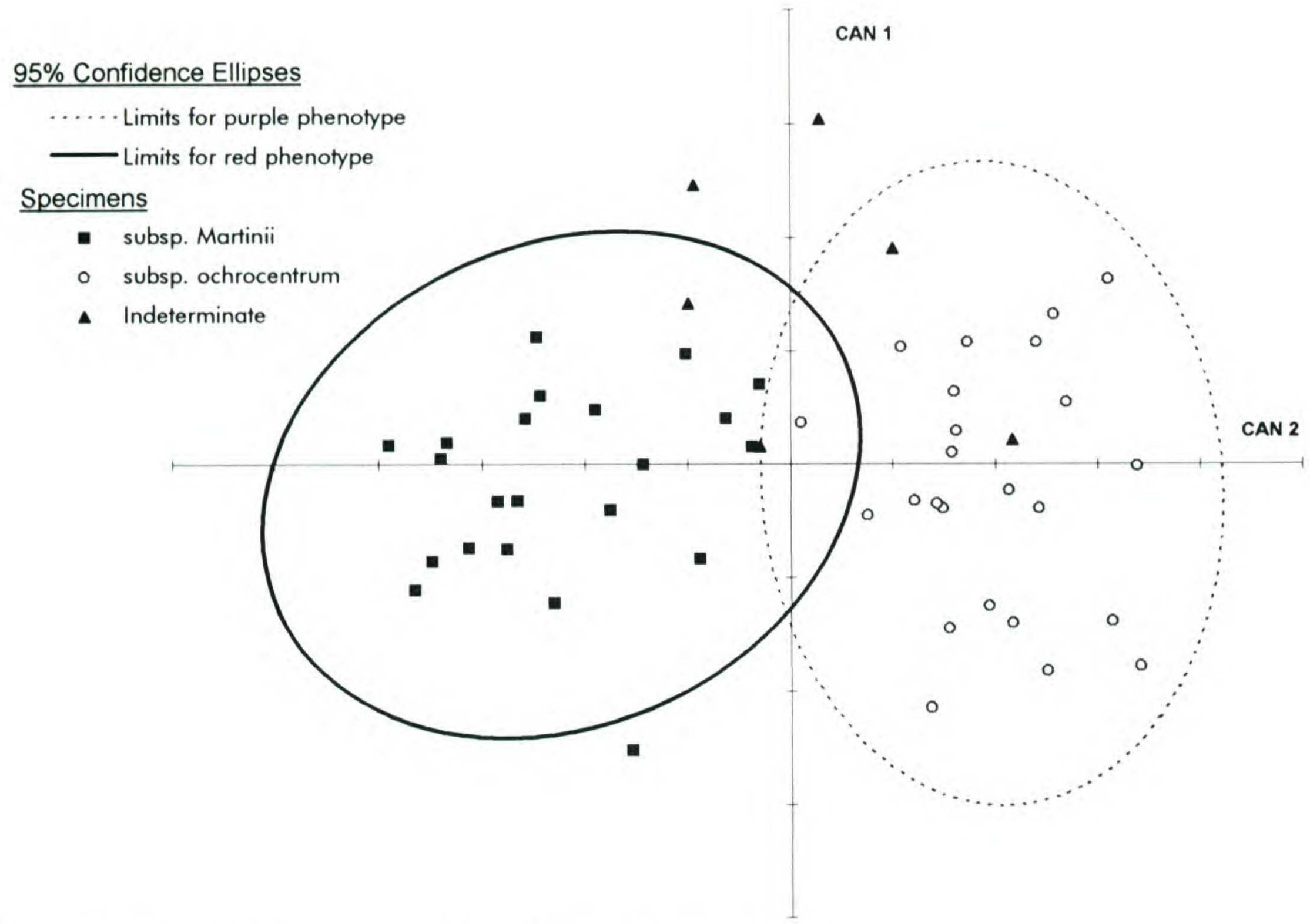

Figure 2. Canonical discrimination and group 95% probability intervals.

Cirsium ochrocentrum A. Gray subsp. **martinii** P. Barlow, subsp. nov. TYPE: U.S.A. New Mexico: Catron County, T8S, R18W sec. 10, 108.203°W, 33.768°N, 5800 ft. elev., 5 mi. E of the San Francisco River bridge at Reserve, New Mexico, along N.M. Highway 12, 28 July 1997; *Barlow 97-8* (holotype, US; isotypes, ASU, MO, NMC, UNM).

Subspecies haec a subspecie typica differt corollis puniceis, styli apice supra nodum breviore (saepe minus quam 5 mm longo), et antherarum appendicum corporibus plerumque plus quam 2 mm longis (1.5–2.8 mm).

Perennial caulescent herbs to 90 cm. Stems moderately branched, striate-ribbed with a dense, lanate covering of white appressed hairs. Leaves lanceolate, ascending or sometimes deflexed in age; basal leaves much larger than upper leaves. Leaf surface densely white tomentose on abaxial side; adaxial surface loosely arachnoid. Cauline leaves mostly less than 10 mm in decurrence; basal leaves not decurrent, petiolate. Leaf blades pinnatifid shallowly or nearly to the midrib; pinnae cleft into 4 or 5 angular-tipped lobes each terminating in a yellow-colored spine (2–)5(–12) mm long. Heads solitary, borne in leafy panicles. Involucre globose in bud, campanulate at maturity, 25–45 mm high,

Table 1. Significance of canonical correlations between Gila, Santa Fe, and intermediate phenotypes.

Test of HO: The canonical correlations in the current row and all that follow are zero					
	Likelihood ratio	Approx F	Num DF	Den DF	Pr > F
1	0.14728959	5.0845	24	76	0.0001
2	0.75470889	1.1523	11	39	0.3502

Table 2. Total canonical structure between Gila, Santa Fe, and intermediate phenotypes.

Character	CAN1	CAN2
Corolla tube length	0.206	0.210
Corolla throat length	−0.378	−0.016
Corolla lobe length	−0.432	0.172
Style tip length	0.546	−0.011
Anther appendage tip length	0.620	0.184
Anther appendage body length	−0.693	−0.103
Pappus length	−0.091	0.470
Phyllary length	0.214	0.223
Phyllary spine length	0.560	0.436
Terminal leaf spine length	0.444	0.471
Decurrence length of leaf base	0.423	0.201
Leaf length	−0.293	0.223

Table 3. Comparison of means between subspecies. All measurements in mm. All vegetative characters measured at 3rd leaf below capitulum. All variables differed significantly ($P < 0.01$) between subspecies in the Kruskal-Wallis comparison of means.

Character	Subspecies			
	N	*ochrocentrum*	*N*	*martinii*
Corolla tube length	65	18.5 (11–25)	35	16.4 (8–22)
Corolla throat length	65	9.2 (6–12)	35	11.6 (7–17)
Corolla lobe length	65	10.2 (6–12)	35	11.1 (7–15)
Style tip length	64	5.6 (3–8)	33	4.8 (2–7)
Anther appendage tip length	65	1.2 (0.8–2)	34	1.1 (0.7–2)
Anther appendage body length	65	1.6 (0.8–2)	34	2.2 (1–3)
Middle phyllary spine length	65	6.3 (2–12)	35	4.8 (2–12)
Leaf decurrence	49	11.2 (1–30)	23	7.7 (3–36)
Leaf length	48	47.9 (20–133)	24	68.4 (15–134)
Leaf spine length	45	8.0 (2–13)	24	6.5 (0.8–12)

22–45 mm broad. Phyllaries with white glandular ridge when fresh, obscure in dried specimens; margins with scattered arachnoid hairs; tips sometimes red; phyllary spines reflexed at maturity, spines stramineous, 3–12 mm long. Corolla carmine red; lobe and throat of similar length, 7–15 mm; upper tube diameter nearly equal to the throat diameter. Anther appendage free tip opaque, red or pink, rostrate to aristate, 0.8–1.8 mm long. Style tip red or pink, about (3–)5(–7) mm long; ring usually minutely purberulent or trichomes not apparent; style scape longitudinally corrugate below ring. Cypselas compressed or somewhat trigonal, evenly brown or with yellow and reddish streaks, 6.5 mm long. Pappus white, 25–43 mm long; bristles sparsely plumose toward tip, densely plumose toward base, apices slightly expanded.

The distribution of this subspecies largely coincides with the Apachian floristic areas as defined by McLaughlin (1986). The Apachian floristic area includes much of southeastern Arizona and southwestern New Mexico and has close affinities with the flora of the Sierra Madre Occidentale in Mexico. The division between these subspecies closely corresponds to the division between the Gila River Drainage and that of the Rio Grande and Colorado River drainages.

The type material for *C. ochrocentrum* (Gray, 1849) was originally collected from hillsides around Santa Fe, New Mexico. *Cirsium ochrocentrum* subsp. *ochrocentrum*, the "Santa Fe" phenotype, from the New Mexico Rio Grande river valley and points eastward, is a relatively homogeneous morphological group. The more western subspecies *martinii* differs from the typical subspecies in distribution, corolla color, and continuous morphological characters. These taxa separate in phenetic analysis along a discriminant function axis primarily composed of anther appendage tip and body length, phyllary spine length, and style tip length. Morphological intermediates between these two forms are observed in a narrow zone along the Continental Divide. In these areas, populations may have intermediate flower colors to the red or purple phenotypes or mixed populations of both colors. Although these intermediate populations were variable in many characteristics, there is no decrease in pollen stainability or other indications of loss of fertility in these areas (Barlow, 1992). The subspecies rank is appropriate to separate these taxa for the following reasons: (1) there is intergradation between the Gila phenotype and more typical Santa Fe thistles in the zone of contact between them; and (2) these taxa have overlapping distributions of characters, which only differ in population means. It is also of note that in populations of what superficially appears to be the typical subspecies in Jeff Davis County, Texas, specimens have extremely short style tips, and may be another segregate of *Cirsium ochrocentrum*. Although Hsi (1960) discussed this red-corolla form of *C. ochrocentrum*, my analysis does not support recognition of a taxon based on cypsela as a diagnostic characteristic (Table 3).

The subspecies *martinii* may be distinguished in the field from subspecies *ochrocentrum* by its bright-red florets, short style tips and spines, and less prominent decurrence of leaf bases. It differs from *Cirsium arizonicum*, another species with red corollas, by its globose involucres and its large capitula with more than 120 florets per head as compared to fewer than 60 florets in the cylindrical capitula of the Arizona thistle.

This subspecific epithet commemorates William

C. Martin, who inspired a generation of students with his love of plants and his dedication to botanical education.

Paratypes. U.S.A. **Arizona:** Cochise County, 6 mi. E of Portal, *Cazier 114971* (ARIZ); Huachuca Mts., *Lemmon 2790* (US); Miller Canyon Rd. in Huachuca Mts., *McGill & Lehto 87615* (ASU). Graham County, Ft. Grant, *Shreve 5213* (ARIZ). Mojave County, 3 mi. NW of Mt. Dellenbaugh on Shivwits Plateau, *Holland 745* (UNLV); T34N, R12W, S32 along roadside, *Coombs & Bundy 2597* (ARIZ). Navajo County, Heber, *Lehto 1984* (ASU); Fort Apache, *Whitehead & Bolles 1626* (ARIZ). Pima County, just N of Ophir Gulch, 4 mi. N & 2 mi. W of Sonoita, *Tramanto t-10* (ARIZ). Santa Cruz County, along Rt. 82, 1.8 mi. S of junction of Rt. 83, *McGill & Pinkava 6730* (ASU); Ted Knipe Property, ca. 3 mi. W of Sonoita on Rt. 82, *Reeves & Lehto 67561* (ASU). Yavapai County, Mingus Mt., Mingus Water Shed, station B., *Demaree 46081* (ASC); 1 mi. from Perkinsville, *C. Grue 72A024* (ASC); 1.5 mi. S of Dewey on AZ 69, *Keil K11448* (ASU, WTS). **New Mexico:** Catron County, cliff, *Castetter 8362* (UNM); road cut across rock outcrop, 3 mi. W of Reserve, *Weber & Salamun 12801* (COLO, UT); Lower Plaza, Frisco, *Wooton 1900* (NMC). Grant County, Gila NF, T21S, R16W, 8 mi. S of Silver City, *Gentry & Jensen 2274* (BRY, COLO, ARIZ); 15 mi. S of Red Rock, *Maquire, Ranchards & Moeller 11424* (ARIZ). Hidalgo County, 5 mi. S of Hachita, *Castetter 10370* (UNM); 1 mi. N of Rodeo, *Cazier 431* (ASU); Arroyos W of Hermanos, *Clark 10740* (UNM). Luna County, Cook, *A. T. Hyatt 1907* (NMC).

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